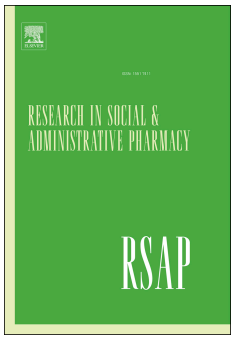
Accepted Manuscript



The Fourth Industrial Revolution: Will it change pharmacy practice?

Darrin Baines, Lotte Stig Nørgaard, Zaheer-Ud-Din Babar, Charlotte Rossing

PII: S1551-7411(19)30355-9

DOI: https://doi.org/10.1016/j.sapharm.2019.04.003

Reference: RSAP 1249

To appear in: *Research in Social & Administrative Pharmacy*

Received Date: 1 April 2019

Accepted Date: 4 April 2019

Please cite this article as: Baines D, Nørgaard LS, Babar ZUD, Rossing C, The Fourth Industrial Revolution: Will it change pharmacy practice?, *Research in Social & Administrative Pharmacy* (2019), doi: https://doi.org/10.1016/j.sapharm.2019.04.003.

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

ACCEPTED MANUSCRIPT

The Fourth Industrial Revolution: will it change pharmacy practice?

Darrin Baines PhD[1], Lotte Stig Nørgaard PhD Pharm[2], Zaheer-Ud-Din Babar PhD[3], Charlotte Rossing PhD Pharm[4]

[1]Professor of Health Economics, Department of Accounting, Finance & Economics, Bournemouth

dbaines@bournemouth.ac.uk

[2]Associate professor at Faculty of Health and Medical Sciences, University of Copenhagen

lotte.norgaard@sund.ku.dk

[3]Professor in Medicines and Healthcare, Department of Pharmacy

Director, Pharmaceutical Policy and Practice Centre

School of Applied Sciences, University of Huddersfield

z.babar@hud.ac.uk

[4]Director of Research & Development, Pharmakon, Danish College of Pharmacy Practice, Denmark

cr@pharmakon.dk

ACCEPTED MANUSCRIPT

ACCEPTED MANUSCRIPT

Abstract

The industrial world is at the beginning of a Fourth Industrial Revolution (4IR). This era will radically change the human use of technology, with major implications for the ways people live and work. This commentary asks: will 4IR change pharmacy practice? The first three revolutions created the pharmaceutical industry and gave pharmacists a near-monopoly over drug supply. 4IR could do the opposite and create alternative, non-pharmaceutical means of treating patients as well reducing the involvement in medicines supply. If the pharmacy sector becomes stuck in traditional, linear thinking that assumes the future will be an extension of the past, then the fourth revolution may be less of an opportunity and more of a threat. The sector faces the "innovator's dilemma" when responding to 4IR. Should the pharmacy profession disrupt their current activities in order to: (i) do things better, (ii) do new things, and (iii) deter competition? To maintain its position in the medical marketplace, pharmacy needs to discover how to work with AI, robotics, IoT, autonomous vehicles, 3-D printing, nanotechnology, biotechnology, materials science, energy storage, and quantum computing. If the new game is understood, pharmacists may become the playmaster of tomorrow. If not, then the practice of pharmacy may be replaced by innovative new ways of meeting patient pharmaceutical needs.

ACCEPTED MANUSCRIPT

ACCEPTED MANUSCRIPT

The Fourth Industrial Revolution: Will it change pharmacy practice?

The industrial world is at the beginning of a Fourth Industrial Revolution (4IR).[1] This era will radically change the human use of technology, with major implications for the ways people live and work. The first industrial revolution started after 1760 and led the move from hand production to machines, which created many new industrial processes including chemical manufacturing. The second revolution occurred after 1870 and was initially stimulated by new methods for the mass production of steel, but then spread to the developments in other industries such as chemicals and transport. The third revolution (the "Digital Age") began in the 1960s with the development of electronics, information technology (IT) and automated production. All of these revolutions have shaped the practice of pharmacy that we recognise today.

Society is now entering the 4IR, which will create new capabilities for people and machines through the adoption of technologies such as the Internet of Things (IoTs), which connects devices and physical objects (referred to as "things") via electronic sensors to the internet.[2] The IoTs is currently being used for a range of pharmacy-related activities such as improving medication adherence and monitoring drug storage.[3] In response to such innovations, the purpose of the commentary is to ask: will 4IR change pharmacy practice? The first three revolutions created the pharmaceutical industry and gave pharmacists a near-monopoly over drug supply. In contrast, 4IR could do the opposite and create alternative, non-pharmaceutical means of treating patients as well reducing the involvement in medicines supply. Just because pharmacists managed to successfully adapt in the past, it should not be assumed that 4IR will support the development of pharmacy as an industry and a profession in the future. On the contrary, non-pharmacy players such as Amazon and Google may seriously disrupt the *status quo*.

Throughout its history, pharmacy has successfully adopted a range of "general purpose technologies" (GPTs) that were developed during the first three industrial revolutions. GPTs are defined as technologies that affect an entire economy and have the potential to disrupt the economic life of whole societies.[4] To date, only 24 GPTs have emerged,

ACCEPTED MANUSCRIPT

including the steam engine, trains, electricity, computing, the internet, artificial intelligent and blockchain.[5] During their history, apothecaries, chemists and druggists and modern-day pharmacists have all used GPTs to: create the pharmaceutical industry; invent new processes for making dyes; improve brewing techniques; advance photography and film-making; introduce robotic and barcode dispensing; harness sensor technology in dossetts and pill boxes. As this list suggests, pharmacy evolved because of its industrial-scale adoption of GDTs from the first three revolutions. A key question, therefore, will this trend continue during the fourth wave?

For all industrial sectors, the consequences of the 4IR are predicted to be unprecedented. Schwab[1, p.2] describes the potential risks and benefits:

> The changes are so profound that, from the perspective of human history, there has never been a time of greater promise or potential peril. My concern, however, is that decision-makers are too often caught in traditional, linear (and non-disruptive) thinking or too absorbed by immediate concerns to think strategically about the forces of disruption and innovation shaping our future.

Just as these words apply to all industries, Schwab's message also applies to pharmacy. If the pharmacy sector is stuck in traditional, linear thinking that assumes the future will be an extension of the past, then the fourth revolution may be less of a promise and more of a threat. In consequence, outsiders may take over many activities that have traditionally been considered to be solely pharmacy work. For instance, online dispensaries may move business away from local "brick and mortar" pharmacies. Phone apps may replace the need for face-to-face pharmaceutical care, with online platforms for patient counselling. In response, there is a pressing need for the pharmacy sector as a whole to consider how 4IR will affect the future of its clinical and commercial activities.

Technology types

Writing about pharmacy, Baines *et. al.* define "technology' as the "dynamic clustering of techniques, methods, skills and processes used in the production of goods or services or in

the achievement of outcomes that deliver desired benefits for consumers".[6] This definition suggests that fourth wave technologies could: (i) help pharmacists do what they currently do better, (ii) extend the range of outcomes the profession is able to produce, (iii) a combination of both. However, a technology is not just a cultural product, but in itself a producer of culture.[7] For instance, 4IR could create a renaissance for community pharmacy premises, with dispensing, patient counselling and other services being made more cost-effective by technologies such as mobile phone apps.[8] Similarly, pharmacy could extend its services into data analytics using "big data", which leads to: (i) an unprecedented growth in data volumes, (ii) a rapid increase in the velocity or speed of data creation, and (iii) an extension in the variety of data types available.[9]

If no competition exists, fourth wave technologies may promote a viable future by creating a more efficient, expansive pharmacy sector. Applying technologies may support pharmacy as a valid player in the healthcare sector. However, the sector as a whole faces the "innovator's dilemma" when responding to 4IR. Should the pharmacy profession disrupt their current activities in order to: (i) do things better, (ii) do new things, and (iii) deter competition? These are pressing issues in need of widespread debate because they will shape the future of pharmacy practice. If pharmacists do not disrupt their own working methods, perhaps external players will seize the chance to change the ways in which pharmacy and related services are provided.

Pharmaceutical care

Leading pharmacists are aware that technology can disrupt society and the economics of pharmacy. Over thirty years ago, Hepler argued that technology, economics, and social values are the major forces shaping pharmacy's future.[10] Amongst the technological forces shaping pharmacy practice, Hepler cited computers, robotics, communications and therapeutics as the stimulants of change. Amongst the important economic factors, he listed managed care, payment for outcomes and the marketing services as the factors most likely to have the largest effect. Finally, Hepler believed that an aging population, the weakening of professional authority and a deterioration in pharmacy's public image were

having the biggest social impact on the profession. In response, he argued that pharmacists should return to their fundamental relationship with society by accepting the ethical responsibility for drug-use control. To accomplish this goal, pharmacy would need to undergo a process of occupational reconstruction and self-renewal in order to become providers of a new societal model of practice, which Hepler and Strand refer to as "pharmaceutical care".[11, p.539] They state:

> Pharmaceutical care is the responsible provision of drug therapy for the purpose of achieving definite outcomes that improve a patient's quality of life. These outcomes are: (1) cure of a disease, (2) elimination or reduction of a patient's symptomatology, (3) arresting or slowing of a disease process, or (4) preventing a disease or symptomatology.

Pharmaceutical care was developed during the third industrial revolution.[12] In the last thirty years, advances in computing, robotics, communications and therapeutics have all been stimulants of change. For instance, most pharmacies are computerized, just as robotics dispensing is growing fast in use.[13] The question, therefore, arises: how will pharmacy respond to the opportunities and challenges offered by the 4IR?

In the healthcare sector, the 4IR revolution is happening much faster outside of pharmacy than within. To date, the main developers and players involved in 4IR tend not to be pharmacists. This raises serious questions about the future development of the pharmacy sector.[14] For instance, what will happen to local pharmacies if most dispensing moves online? What is the professional role of the pharmacy if dispensing disappears? After thirty years of struggling to establish clinical pharmacy as a viable model of practice, what will happen to patient counselling if innovative technologies bypass pharmacy and go straight to consumers? In response to such questions, stakeholders in pharmacy should engage in open discussion about the opportunities and the threats of 4IR.

Health technology

ACCEPTED MANUSCRIPT

ACCEPTED MANUSCRIPT

The World Health Organization defines “health technology” as the “application of organized knowledge and skills in the form of devices, medicines, vaccines, procedures and systems developed to solve a health problem and improve quality of lives”. This definition goes beyond the everyday definition of “technology” as manufactured objects such as mobile phones or computing such as Artificial Intelligence (AI) used by human beings either for their own personal ends or for the production of goods and services for sale.[15,16] Researchers from the science technology society argue that the term technology contains at least three components, which are to be present simultaneously in order for a piece of technology to be functioning, namely: (i) hardware (tools, machines, devices), (ii) knowledge (knowledge and knowledge interest embodied in the hardware) and (iii) organization (the ensuing systematic procedures or mode of work which goes with the use of the hardware.[17,18] These technology definitions all include the wider dynamic surrounding the use of technologies to include the actions of humans using clinical procedures and health systems to help create wellbeing and quality of life. In response, pharmacists would benefit from viewing technologies as embedded in, and inseparable from, the overall production processes that supply drugs and generate patient wellbeing.[19]

Traditionally, pharmacy has based its operational procedures for dispensing and pharmaceutical care on the assumption that patients will interact with pharmacists face-to-face. According to Schwab, fourth wave technologies will advance communications and connectivity in ways that connect billions of people to the internet in innumerable ways. Future developments in internet-based technologies could remove pharmacists from the process of care delivery. In other words, 4IR could disrupt physical, on-the-ground networks between doctors, patients and pharmacists and create cyber, in-the-cloud connections that promote “direct-to-consumer pharmacy”. For instance, big data and AI could identify patient needs, track medicines usage, and search for pharmaceutical problems. All of this could happen automatically based upon algorithms and specified treatment routines, without the input from pharmacists in real time. Moreover, these services could be provided outside of traditional pharmacy locations (such as community

and hospital pharmacies), existing only in cyberspace with no or only limited face-to-face contact.

In developing the pharmaceutical care paradigm, Hepler and Strand were exacting in their analysis of the evolution of pharmacy and forceful in outlining their vision of pharmacy's role in society. Whilst the technological, economic and, social challenges they described thirty years ago have moved on, the underlying issue have not really: how should pharmacy re-professionalise itself to create value and wellbeing for patients in an ever-evolving society? The 4IR has made this question pertinent again. Online, direct-to-consumer pharmacy has the power to disrupt the local, face-to-face networks that have long existed between doctors, patients, and pharmacists. In response, now is the time for a debate about the opportunities and threats to medication safety that will be caused by the disruptive 4IR, with a specific focus on what pharmacy can contribute in a rapidly changing healthcare sector.

Evidence suggests that external parties will be happy to create a new future for the industrial activities that have traditionally been the monopoly of the profession of pharmacy.[20] The technologies introduced by 4IR are likely to disrupt the ways in which drugs are supplied and how patients receive support in their medicines taking. In response, pharmacy urgently needs a new roadmap, an innovative blueprint in order to survive the disruption ahead. To maintain its position in the medical marketplace, pharmacy needs to discover how to work with AI, big data, augmented reality and the range on innovative technologies that are beginning to disrupt patient care. If the new game is understood, pharmacists may become the playmaster of tomorrow. If not, then the practice of pharmacy may be replaced by innovative new ways of meeting patient pharmaceutical needs.

ACCEPTED MANUSCRIPT

ACCEPTED MANUSCRIPT

References

1. Schwab, K. The Fourth Industrial Revolution. Switzerland: World Economic Forum; 2017.
2. Gatouillat, A., Badr, Y., Massot, B., & Sejdić, E. (2018). Internet of medical things: A review of recent contributions dealing with cyber-physical systems in medicine. *IEEE Internet of Things Journal*, *5*(5), 3810-3822.
3. Mambou, E. N., Nlom, S. M., Swart, T. G., Ouahada, K., Ndjiongue, A. R., & Ferreira, H. C. (2016, April). Monitoring of the medication distribution and the refrigeration temperature in a pharmacy based on Internet of Things (IoT) technology. In *2016 18th Mediterranean Electrotechnical Conference (MELECON)* (pp. 1-5). IEEE.
4. Helpman, E. (Ed.). *General Purpose Technologies and Economic Growth*. Cambridge, MA: MIT press; 1998.
5. Lipsey, R. G., Carlaw, K. I., & Bekar, C. T. *Economic Transformations: General Purpose Technologies and Long-term Economic Growth*. OUP Oxford; 2005.
6. Baines, D., Bates, I., Bader, L., Hale, C., & Schneider, P. Conceptualising production, productivity and technology in pharmacy practice: A novel framework for policy, education and research. *Human Resources for Health*, 2018. *16*(1), 51.
7. Nørgaard LS, Sørensen EW, Morgall JM. Social constructivist analysis of a patient medication record experiment – why a good idea and good intentions are not enough. *Int J Pharm Pract* 2001; 8(4): 237-246.
8. Baines, D. (2015a). Community pharmacies deserve a renaissance. *Int Pharm J* . 2015; 46-47.
9. Laney, D. 3D data management: controlling data volume, velocity and variety. META Group Inc, 2001.
10. Hepler, C. D. Unresolved issues in the future of pharmacy. *Am J Health-Syst Pharm*. 1988;*45*(5),1071-1081.
11. Hepler, C. D., & Strand, L. M. Opportunities and responsibilities in pharmaceutical care. *Am J Hosp Pharm*. 1990;*47*(3):533-543.
12. Daemmrich, A. Invention, innovation systems, and the Fourth Industrial Revolution. *Technology & Innovation*. 2017;257-265.

ACCEPTED MANUSCRIPT

13. Chow, M. S., Chow, S. L., & Kember, D. A conceptual basis and key components for pharmacy core curriculum in the age of artificial intelligence. *Journal of Asian Association of Schools of Pharmacy*. 2018;15-20.
14. Rossing, C. Implementation of pharmaceutical care in community setting. In da Costa, F. A., van Mil, J. F., & Alvarez-Risco, A. The Pharmacist Guide to Implementing Pharmaceutical Care; 2018.
15. Feenberg, A. *Critical Theory of Technology* (Vol. 5). New York: Oxford University Press; 1991.
16. Vyas, M., Thakur, S., Riyaz, B., Bansal, K. K., Tomar, B., & Mishra, V. (2018). Artificial Intelligence: The Beginning of a New Era in Pharmacy Profession. *Asian Journal of Pharmaceutics*. 2018;*12*(2):72-76.
17. Nørgaard LS. The Development of Patient Medication Records in Denmark - a Social Constructivist View. PhD.-thesis. Department of Social Pharmacy, The Royal Danish School of Pharmacy, 1996.
18. MacKenzie, D and Wajcman, J. (eds). The Social Shaping of Technology. Milton Keynes and Philadelphia: Open University Press; 1985.
19. Baines, D. L., Gahir, I. K., Hussain, A., Khan, A. J., Schneider, P., et al. A scoping review of the quality and the design of evaluations of mobile health, telehealth, smart pump and monitoring technologies performed in a pharmacy-related setting. *Frontiers in Pharmacology*, 2018;*9:*678.
20. Baines, D. (2015). If we understand the past we can plan for the future. *Prescribe*. 2015;*26*(17), 16-20.

ACCEPTED MANUSCRIPT

View publication stats